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ANNUAL REPORT OF THE 1986 WESTERN PACIFIC LOBSTER FISHERY

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FOR

Western Pacific Regional Fishery Management Council

NOT FOR PUBLICATION

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PREFACE

This is the fourth annual report of the lobster fishery managed under a fishery management plan (FMP) prepared by the Western Pacific Regional Fishery Management Council (WPRFMC) since the plan came into effect in March 1983.

The western Pacific lobster fishery includes three management areas: permit area 1, the Northwestern Hawaiian Islands (NWHI), permit area 2, the main Hawaiian Islands (MHI), and permit area 3, the islands of the territories of American Samoa and Guam. No permits were issued for area 3, and only one vessel was issued a permit to fish in area 2 in 1986. Since the majority of the fishing took place in the NWHI, the bulk of the material presented in this report will relate to permit area 1. The MHI are included in certain summary statistics and are referred to when appropriate. Fishing activities in the MHI, and American Samoa and Guam state or territorial water (within 3 nmi from shore) are not covered in this report since they lie outside the jurisdiction of the FMP (3 to 200 nmi from shore).

This report provides the technical information stipulated in the Final Combined Fishery Management Plan for Spiny Lobster Fishery of the Western Pacific Region. It also: 1) presents fishery information provided by the Fishery Management Research Program, Southwest Fisheries Center (SWFC) Honolulu Laboratory, National Marine Fisheries Service (NMFS), NOAA, 2) summarizes biological research information provided by the Insular Resources Investigation, SWFC Honolulu Laboratory, and 3) incorporates information on the activities of the WPRFMC Crustacean Monitoring Team (as provided by P. D. Gates, WPRFMC staff biologist). Separate sections were prepared by the Western Pacific Program Office (WPPO) and the Enforcement Officer of the Southwest Region, NMFS.

INTRODUCTION

This report provides details on the commercial lobster fishery in the fishery conservation zone (FCZ) of Hawaii. Current catch, fishing effort, and revenue statistics are provided along with revised revenue and weight information for 1984 and 1985. The report also provides information on the biological condition of the Northwestern Hawaiian Islands (NWHI) lobster stocks and gives information on experimental escape vent trials. Information from the Western Pacific Regional Fishery Management Council (WPRFMC) Crustacean Monitoring Team is incorporated into the report. The Western Pacific Program Office (WPPO) of the Southwest Region (SWR), NMFS, contributed a section on administration of the fishery management plan (FMP) and the Enforcement Officer of the SWR reported on his activities. A brief description of marine mammal interactions is also included.

The NWHI lobster fishery targets two species of lobster: the spiny lobster, Panulirus marginatus, and the common slipper lobster, Scyllarides squammosus. A second species of slipper lobster known as the ridge-back slipper, S. haanii, is also taken in commercial quantities. However, it accounts for <5% of total slipper lobster landings. In addition, two other species, the green spiny lobster, P. penicillatus, and the Chinese slipper lobster, Parribacus antarcticus, are caught incidentally; however, their commercial quantity is small.

In 1986, 16 federally permitted vessels operating in the FCZ of the Hawaiian Archipelago caught a record 1,005 metric tons (t) of spiny and slipper lobsters (wet weight). Gross revenue is estimated to be in excess of $5.997 million based on ex-vessel price, an increase of 1.7% over 1985 revised revenue estimates. Spiny lobster products continue to be the top generator of revenue with 521 t landed in 1986 valued at $3.7 million. However, spiny lobster revenue is down 12.4% from last year's record catch valued at $4.3 million. Slipper lobster products rose in 1986 to a record 484 t worth $2.3 million, a 36.7% increase over 1985 revised revenue estimates.

While catch per unit effort (CPUE) declined with a 34% increase in trap-nights, the combined spiny and slipper lobster catch remains stable. Research indicates that the NWHI lobster stocks are in stable biological condition though heavily exploited on certain banks. Escape vent trials indicate that there would be a substantial release of sublegal lobsters if such vents were employed in the fishery, with positive economic and biological benefits.

Although the lobster stocks appear to be stable, fishing activity does not. At least five of the larger lobster fishing vessels left the fishery for the west coast at the end of the 1986 season. However, their departure may be offset by the arrival of new entrants in 1987, and several of the owners of the departed vessels have expressed interest in re-entering the NWHI fishery.

LANDINGS

Summaries of NWHI lobster products are presented in Tables 1 and 2 for 1977-86. Landing weight statistics (Table 1) are presented by year, wet weight calculated on a whole animal basis, and total revenue generated for spiny and slipper lobsters. Table 2 presents a breakdown of revenue by product type, either live, frozen whole, or frozen tails, in actual product weight.

Revised revenue figures have been prepared for 1984 and 1985 for both spiny and slipper lobsters. The basis for these revisions are explained later in this section. Revenue and weight figures for 1986 are preliminary estimates pending final collection of information from revenue reports.

Total gross revenue for the NWHI lobster fishery was $5.997 million in 1986 which would place the lobster fishery equal or second to tunas as the top generator of fishery revenue in Hawaii. This represents an increase of 1.7% over the 1985 revised estimate of $5.9 million.

Spiny lobster revenue was $3.7 million in 1986, down 12.4% compared to 1985 revenue while wet weight declined 20.3% from revised estimates for 1985. Slipper lobster revenue was $2.3 million, up 38.3% from 1985, and wet weight increased by 14.5% (Fig. 1).

In 1986, 521 t of spiny lobster and 484 t of slipper lobster were landed from the NWHI. Revised 1985 figures recorded 654 t of spiny lobster and 423 t of slipper lobster being landed.

Spiny lobster landings were 30 t in 1977 and rose to 350 t by 1981, when live lobster was the main product type (Fig. 2). Production declined to 80 t during a transitional period (1982-83) from live lobster to frozen tail production. Production rose quickly from 1983 until 1985 when 654 t of spiny lobster were landed. The reported 1985 spiny lobster landings rank the NWHI as the number two producer of spiny lobster in the United State after Florida (Samples and Gates 1987) with the same share expected in 1986.

Slipper lobster have occurred as incidental catch since 1977; however, reported landings for slipper lobster only begin in 1984. Estimated landings of slipper lobster were 100 t in 1984, rising to 423 t in 1985, and are estimated to be 484 t in 1986. The NWHI now appears to be the largest producer of slipper lobster in the United States and ranks second or third behind Thailand or Australia worldwide (Samples and Gates 1987).

Product Type

Frozen lobster tails continue to be the main product type of the NWHI lobster fishery (Table 2). In 1986 sales of frozen tails accounted for 92.2% of the total estimated revenue generated by spiny lobster, with the live and frozen whole lobster accounting for only 4.2 and 3.6%, respectively. For slipper lobster, frozen tails accounted for 99.0% and

frozen whole 1.0%. In 1986 several vessels that brought in live lobster had significant numbers of slipper lobsters mixed with spiny lobsters yet the sales were reported as only live spiny lobster. Therefore, the 4.2% shown as the proportion of live spiny lobster is estimated to have been partially slipper lobster revenue. Wholesalers and fishermen indicate that the same price is paid for live slipper lobster as for live spiny lobster (between $5 and $5.25 per lb).

The relative contribution of product types is shown in Figure 3. Spiny lobster tails provide the largest source of income at an estimated $3.5 million in 1986. This figure is 12.3% below the 1985 updated value of $4.1 million. Live lobster revenue also has declined by almost 44%, with landings down 48.3%. The price per pound for live lobster rose from $4.71 in 1985 to $5.11 in 1986. Frozen whole lobster revenue jumped substantially in 1986 due to a substantial increase in weight landed (550% increase over 1985 landings). The 1986 price for frozen whole spiny lobster ($3.84 per lb) was down from the 1985 price ($4.08 per lb), and this is the only category where there has been a decline in unit price during the last year. This was due in part to one large load that was sold well below average 1985 price.

Slipper lobster tails were the second largest generator of revenue for the fishery after spiny lobster tails. However, while spiny lobster tail total revenue declined by 12.3% in 1986 as compared to 1985, slipper lobster tail revenue jumped by 37%. The estimated value of slipper lobster tails in 1986 ($2.284 million) is almost equal to the value of spiny lobster tails in 1984. Frozen whole slipper lobster revenue was up 6.7 times in 1986 over 1985 figures, but it is still a very small portion of the overall slipper lobster revenue picture. Live slipper lobster were only reported by one vessel, but observations by dockside samplers indicate that a growing part of the revenue generated by live spiny lobster sales is in fact slipper lobster. Fishermen are paid the same for slipper lobster as spiny lobster (around $5-$5.25 in 1986), and since the composition of live loads is not known by the fishermen, the revenue normally is reported under the spiny lobster live category. So the weight and revenue figures presented for live spiny lobster are more representative of "live lobster."

Several other incidental species caught in traps such as octopus and bottom fish generate revenue for fishermen. The magnitude of these products is relatively small and their total ex-vessel value is estimated to be <$50,000. Octopus may be landed in relatively large quantities (1000's of lb per trip) and sold for between $0.50 and $1.50 per lb. Bottom fish may be landed frozen and sold, although many are given away to crew or friends.

Revised Revenue Estimation Procedure

Annual landings information for spiny lobster caught in the NWHI have been collected by the Southwest Fisheries Center (SWFC) Honolulu Laboratory since 1977. During 1977-79, the information was voluntarily supplied by fishermen to the SWFC Honolulu Laboratory on a confidential basis. Between

1980 and 1982 when the FMP was being formulated, information on landings and sales was obtained by the SWFC Honolulu Laboratory through direct interviews at the time of vessel offloading. The FMP went into effect in March 1983, and since then fishermen have been required by law to turn in a Trip Sales and Processing Report within 72 h of selling any spiny lobster products. The SWFC Honolulu Laboratory is responsible for collecting and compiling the Sales and Processing reports. Information is recorded by product type, indicating the weight and revenue obtained for each product.

The Trip Sales and Processing Reports require only that the fishermen document **spiny** lobster landings. Although the common and ridge-back **slipper** lobster landings are usually reported together on a voluntary basis by most fishermen, records are not complete. As a result, estimation of slipper lobster revenue has been required and in 1986, a revised estimation procedure was employed by the SWFC Honolulu Laboratory.

In 1984 it was recognized that slipper lobster was becoming an important component of the NWHI lobster fishermen's catch. By April 1985, slipper lobster was the major component of the catch and many fishermen were reporting slipper lobster sales along with their spiny lobster revenue figures. Because of the multispecies nature of the fishery, spiny lobster revenue figures collected before May 1985 were reanalyzed to see if they included slipper lobster components. Initial indications were that a great deal of 1984 and 1985 spiny lobster revenue figures were "contaminated" with slipper lobster components. The 1985 Annual Report (Skillman et al. 1986) was the first attempt to separate revenue by species. During 1986, however, interviews with fishermen and renewed analysis of the revenue reports indicated that in most instances only a small percentage of the revenue figures for 1984 and 1985 were representative of multispecies catch and that slipper lobster revenue was generally unreported. Therefore, the 1984 and 1985 revenue statistics have been revised substantially.

Spiny lobster revenue and weight data for 1984 and 1985 are complete. Slipper lobster data have been estimated using the voluntary information provided by fishermen. For 1984 through 1986, the average annual ex-vessel price per pound for frozen lobster tails was calculated from the statistics in Table 2. These prices are multiplied by an estimate of the weight of slipper lobster landed for each unreported (revenue) trip. The estimated weight of slipper lobster tails landed for each unreported trip is obtained from the average weight of slipper lobster tails landed on reported trips, which is derived by dividing the total weight recorded on the Sales and Processing Reports by the number of individual lobsters retained as recorded on Daily Lobster Catch Reports. The Daily Lobster Catch Reports also provide the number of lobsters landed on unreported (revenue) trips. Slipper lobster revenue and weight data were reported for 8 (1984), 32 (1985), and 42 (1986) trips.

Spiny lobster Trip Sales and Processing Reports have not been received for six trips in 1986. The weight and revenue for these trips have been estimated using information obtained from interviews with vessel captains at the time of offloading.

CATCH AND FISHING EFFORT

Catch and effort statistics are derived from the Daily Lobster Catch Report which, by law, are to be filled out within 24 h of each fishing day. Information on catch and effort are specified by each area fished. Summaries of catch and effort data by date of landing are sent to various fisheries management agencies each month. If date of haul is used to create these periodic summaries, then potentially 3 months could pass before complete reporting is available. Therefore, all catch and effort statistics presented in this section are computed using **date of landing** as has been presented in previous annual reports. The summary information presented here encompasses fishing effort from trips which landed lobster in the 1986 calendar year.

One FMP permitted vessel fished around the MHI. As in previous years, the catch was very small in comparison to the NWHI catches. Therefore, the bulk of the data presented deals with the NWHI fishery.

Catch Composition

In 1986, there were 896,407 legal, 307,864 sublegal, and 155,564 berried spiny lobsters caught and 1,237,527 total slipper lobsters reported caught (Table 3). Since many lobster fishermen report the total catch of slipper lobster without separating them into berried, legal, or sublegal categories, only the total number of slipper lobster is reported here. Not all of these are retained since berried slipper lobster must be returned and many of the smaller slipper lobster may be returned.

In 1986, fishing encompassed all of the banks and islands of the NWHI. Nine different banks were fished by more than three different vessels, seven by two or less, and the MHI by one vessel. Present Federal confidentiality statutes dictate that summary statistics can only be presented for specific areas fished by three or more vessels, and the remaining vessels will be grouped into an "Other" category.

In 1985, 13 islands and banks were fished, which included all the major NWHI areas. These included the original banks fished since the early 1980's (Maro Reef, Necker Island, Gardner Pinnacles) and a variety of the smaller banks. In 1986 Maro Reef, Necker Island, St. Rogatien Bank, and Gardner Pinnacles produced the most legal spiny lobster in descending order. The same trend holds true for total spiny lobster catches. These top four banks produced 81.1% of the legal and 82.2% of the total spiny lobster caught in the NWHI lobster fishery. The only bank to make a substantial gain in numerical catch was French Frigate Shoals with an increase of six times in legal and eight times in total spiny lobster catches.

In 1986, 38.5% of the total slipper lobster catch came from Maro Reef. The "Other" category ranks second, while Brooks Banks ranks third in slipper lobster catch. If one combines the total spiny lobster and slipper lobster catches, Maro Reef is again the leader with 38.4%, followed by

Necker Island (16.0%) and St. Rogatien (9.2%). At present the spiny lobster fishery is concentrated around four main banks while the slipper lobster fishery is slightly more dispersed, with the exception of the Maro Reef contribution. This may be due to fishermen still harvesting slipper lobster populations at some of the smaller banks which were relatively unexploited before 1984-85.

The proportion of the various species and legal/sublegal categories are presented in Figure 4. In 1983 slipper lobster made up only 10.5% of the reported catch, with legal spiny lobster leading all categories at 64.6%. In 1985, a dramatic shift took place with 45.4% of the catch attributed to slipper lobster, and only 36.5% of the total catch were legal spiny lobster. In 1986 the fishery had a 52 to 48% split between total spiny to slipper lobster in terms of catch. For 1986, legal spiny lobster were comparable to 1985 figures making up 34.5% of the total lobster catch. Catch composition figures appear to be generally the same in 1986 as was reported in 1985 with no dramatic changes.

Table 4 shows the relative proportions of total spiny to total slipper lobster caught by bank in the NWHI lobster fishery. The overall catch composition reflects little change between 1985 and 1986, while there has been considerable change by bank in 1986. In 1983 Maro Reef, Necker Island, and Gardner Pinnacles were predominately producing spiny lobster. In 1984 this trend continued with newly exploited banks producing mainly spiny lobster. By 1985 with almost all the NWHI areas being fished, catch composition changed. Five banks, including Maro Reef, produced more total slipper lobster than total spiny lobster. In 1986, nine banks (including five in the "Other" category) had larger total slipper lobster catches than total spiny lobster catches. Several banks appear to be spiny lobster producers while others produce mainly slipper lobster. The differences in by-bank production are not known at this time to be due to the relative abundance of the two lobster species or the effects of targeting by the fishermen. Whether this situation remains the same in the future may depend on how well the slipper lobster stocks hold up to commercial exploitation.

Fishing Effort

Fishing effort statistics **by date of landing** for 1983-86 are presented in Table 5. In 1986 there were 1.46 million trap-nights recorded by the NWHI lobster fishermen, an increase of 33.6% over 1985. Fishing effort was greatest at Maro Reef, with 34.2% of all the NWHI trap-night effort, followed by Necker Island, 16.6%; Gardner Pinnacle, 12.5%; and St. Rogatien Bank, 9.6%. The number of days spent fishing by vessels were greatest at Maro Reef and Necker Island, followed by Raita Bank and Gardner Pinnacles. In 1986 Maro Reef and Necker Island had 1,346 and 663 traps on the bank every day of the year, if one were to assume that the gear was hauled every day. Trap-nights per day of fishing were greatest at Gardner Pinnacles and St. Rogatien Bank and lowest at Nihoa Island and Raita Bank with all values falling between 440 and 785 trap-nights per day of fishing.

The seasonal trend of fishing activity by trap-nights through the year for 1984 through 1986 is shown in Figure 5A. Trap-nights, while increasing through time, also show discrete increases throughout the year (Fig. 5B). This can also be shown with spiny lobster tail landings. Landings normally build throughout the year, being lowest at the beginning of each year (January through April) and greatest at year end (September through December) (Fig. 6). This annual trend may be due to declining CPUE (see Recent Developments) but mainly reflects reduced fleet activity at the end of each year. In 1986 there were 60 trips taken by NWHI permitted fishermen. Of these, two FMP permitted trips were in the vicinity of the MHI and two were aborted early due to mechanical problems; however, they did put gear in the water. In effect, 58 trips were made to the NWHI, all of which landed lobster. The present system used by the SWFC Honolulu Laboratory is if a permitted vessel logs any Daily Lobster Catch Reports, then a trip number is assigned. No criteria are used to determine the relative success of each trip.

The effect of multiple night sets (allowing the trap to "soak" more than one night) was investigated by the SWFC Honolulu Laboratory in 1986. There were indications that some vessels were allowing their gear to fish for more than one night. Whether this was by design or a result of new or inexperienced entrants not being able to turn over all their gear in 1 day is unknown. However, the CPUE statistics are calculated as the reported catch divided by the number of nights the trap was in the water. This calculation inherently assumes that catch is proportional to soak time. However, most fishermen believe that the opposite occurs and that CPUE declines with multiple night sets.

Multiple night sets increased from 17 to 25% between 1984 and 1985. However, there is no statistically significant difference in CPUE calculated using only single night sets as compared to the current system of using both single and multiple night sets. This analysis, however, may be reviewed if the percentage of multiple night sets increases significantly (preliminary indications are that in 1986 multiple night sets are down to 19% of the total trap-nights).

Gates and Samples (1986) analyzed the number of trips and trip length. They used "permitted year" (July 1 to June 30) to track increased effort in the fishery over time. While convenient for that study, the data presented in the annual reports are by calendar year. Calendar year more realistically reflects the annual tempo of the fishery because there is reduced activity in January each year. Fishing activity increases through the spring and into the summer, and by the fall, the greatest activity occurs in the fishery. By the year-end holiday season, vessels usually return to port and the fishing year draws to a close (see Recent Developments).

CATCH RATES

In 1986 total spiny lobster CPUE was 0.93 and total slipper lobster CPUE was 0.85. The CPUE for legal, sublegal, and berried spiny lobster was 0.62, 0.21, and 0.11, respectively, in 1986. The by-bank statistics

presented in Table 5 indicate that French Frigate Shoals and St. Rogatien Bank had the highest legal spiny lobster CPUE in 1986 while Lisianski Island, Nihoa Island, and the "Others" category had the lowest. Total slipper lobster catch rates were highest in the "Others" category, followed by Lisianski Island and Brooks Banks. The lowest slipper lobster CPUE was recorded at French Frigate Shoals and Necker Island.

The 1986 CPUE figures for legal and total spiny lobster show a 30.6 and 29% drop, respectively, when compared to 1985 figures. The sublegal spiny lobster catch rates declined by 34.4%, while berried spiny lobster catch rate stayed about the same. Total slipper lobster CPUE has declined 22.0% relative to 1985 figures. Trap-nights in 1986 have increased by 34.0% when compared to 1985. Trap-nights at Maro Reef increased by 32.1%, while at Necker Island, effort in trap-night only rose by 14.7%. Trap-nights jumped at Lisianski Island, Raita Bank, and French Frigate Shoals by 11.7, 9.6, and 4.6 times, respectively. The number of days fished at Maro Reef increased by 43.0% in 1986 when compared to 1985.

Table 6 presents the monthly CPUE of spiny and slipper lobster as calculated using date of landing. In September 1986, legal and total spiny lobster CPUE was highest with values of 1.13 and 1.65. The lowest values for legal and total spiny lobster CPUE were in May (0.23 and 0.52, respectively). Total slipper lobster CPUE was highest in July (1.68) while lowest in December (0.44). These figures have inherent lags due to the effects of trip lengths over 1 month.

In 1983 when only three banks were fished, the legal spiny lobster catch rate was 2.05 and the total spiny lobster rate was 3.53. However, caution must be advised when comparing 1983 and 1986 catch statistics. While CPUE statistics may be a convenient way to compare relative abundance of exploited stocks or the success of fishing activity by fishermen, they must be taken in the context in which they are presented. These CPUE statistics do not reflect any changes to new gear or modifications to existing gear, nor do they reflect changes in targeting patterns by fishermen.

In 1983, the predominant traps were the California two-chambered trap with 5 x 10 cm (2 x 4 in.) welded wire mesh. By the end of 1984, however, all vessels had shifted to black plastic traps with 5 x 5 cm (2 x 2 in.) mesh. These traps were more efficient at catching slipper lobster and sublegal spiny lobster. The catch rate of legal spiny lobster is approximately the same when comparing the original black plastic trap to the wire traps (Polovina, Moffitt, and Clarke 1987). However, the original black plastic traps have been modified with extended cone entrances (in use through 1984 and 1985), and a smaller mesh trap is now in current use. The latest model trap, which incorporates the extended cone entrance, along with 2.5 x 5 cm (1 x 2 in.) mesh is estimated to comprise between 30 and 40% of the presently used gear.

Another factor which has changed dramatically is the targeting patterns of the fishermen. The black plastic traps proved to be much more efficient at catching slipper lobster and a number of fishermen may fish

exclusively for slipper lobster at various times of year. Effort in trap-nights is presently used to calculate CPUE statistics for both spiny and slipper lobster; however, no differentiation is made as to whether the effort was directed at one species or the other. Since the fishermen do not differentiate between spiny and slipper lobster effort, the statistics are not differentiated to allocate effort to the appropriate target species. Therefore, CPUE statistics may be compared between 1985 and 1986, but comparison of 1986 to 1983 may not be as valid. Polovina, Moffitt, and Clarke (1987) addressed this problem in the 1986 NWHI lobster assessment study by using a standardized effort statistic that was calculated from research cruise data.

RECENT DEVELOPMENTS

The fishery in 1986 went through its second straight year of rather intensive fishing effort but appears to be a dramatically different fishery compared to the year-end situation in 1985. Skillman et al. (1986) noted that the 1985 fishing season ended with large cold storage holdings of spiny tails and the prospect of continued intensification of effort by those presently fishing and new entrants. Gates and Samples (1986) documented the dramatic growth of the NWHI lobster fleet from 1983 through 1986 with analysis of permitting activity and fleet dynamics (travel time, time at sea etc.).

However, in 1986, growth in the fishery appears to have slowed. Revenue appears to have stabilized, while total spiny lobster catches have actually decreased. Slipper lobster total weight continued to increase but may have peaked (Polovina, Moffitt, and Clarke 1987). The fishery has developed into a two species fishery split 60 to 40 between spiny and slipper lobster. The multispecies nature of the fishery has evolved even further this year with the continued intensification of effort directed at slipper lobster. Analysis of catch and effort data **by date of haul** confirms this.

Seasonal Patterns

Figures 7 and 8 show the seasonal trends of CPUE for spiny and slipper lobsters, respectively, since 1983 using date of haul. The pattern appears to be of a late winter and early spring season with spiny and slipper lobster catch rates at their lowest levels of the year. This is due primarily to poor weather conditions and possibly to the behavioral habits of the lobsters (large swells cause lobsters to "hole up"). As the spring season arrives, spiny lobster CPUE continues at low levels because the fishermen are still unable to fish the top of the banks and, as a result, set their gear off the edge of the banks in deeper water. However, at this time slipper lobster may be caught in large numbers. Slipper lobster CPUE continues to increase through the spring when the slipper lobster are said to be aggregating, possibly for spawning. As the spring ends and the weather improves, slipper lobster CPUE declines because the fishermen are again able to regularly work on top of the banks and target spiny lobster.

Spiny lobster CPUE continues to climb through the summer into late fall. The fishery then tapers off at year-end for both species.

This seasonal trend can be seen most clearly in 1985 when CPUE for slipper lobster rose dramatically in the spring while spiny lobster CPUE dropped, and then recovered in the summer-fall of the year. The level of spiny lobster CPUE has dropped in all 3 years due to intensive fishing down of larger lobsters and banks with previously unexploited stocks as well as changes in targeting by many fishermen. However, the seasonal trend remains in all 3 years. Slipper lobster CPUE rose uncharacteristically at the end of 1986, but this is due primarily to fishermen targeting slipper lobster when the summer-fall season spiny lobster CPUE did not rise as much as expected. By the end of 1987, slipper lobster will have been exploited intensively for 3 years with almost no restraints and seasonal trends in catch may be more clearly defined.

Prices

Another factor contributing to this shift in effort from spiny to slipper lobster is the continually increasing ex-vessel price of slipper lobster. At the end of 1985, spiny lobster tail prices became flat and cold storage holdings rose. However, frozen slipper lobster tails were reportedly still in heavy demand. The average ex-vessel price of spiny lobster tails has risen 23.9% since 1984 (Fig. 9), while the price of slipper lobster tails has risen by 31.3%. During the last 4 months of 1986, the average ex-vessel price of slipper lobster tails increased to $6.70 per lb and by the end of 1986, many vessels were receiving $7-7.50 per lb or close to 50% more than 1984 ex-vessel prices. During most of 1986, slipper lobster were in high demand and many Hawaii buyers are now willing to buy slipper lobster tails outright, while they "front" (paying the vessel only when the buyer resells the product) the vessels for spiny lobster tails. Fronting incurs greater costs for the vessel owner (i.e., commissions, cold storage, insurance, shipping, etc.), who would rather sell their loads outright as soon as possible after each trip. The demand for slipper lobster tails is expected to bring greater ex-vessel prices in 1987.

In 1986 many of the larger vessels began to pack and sell lobster under their own label. Generally, lobster tails are landed in polyethylene bags which weigh between 22 and 29 lb each when packed. This packaging, while convenient for the vessel, requires sorting, sizing, and repacking by processors, usually all at a cost to the fishermen. However in 1986, several vessels sized, individually packed, and cased lobster tails in corrugated fiberboard containers at sea. This allowed for better storage at sea, handling at the dock, and in many ways made their products more attractive to buyers.

Improvements in processing and packing, and greater external demand outside of Hawaii created tight supplies of frozen lobster tails by the end of 1986, and this trend should continue into 1987. Vessels unloading at the end of 1986 found that lobsters were in high demand. Despite this, at

the end of the 1986 season, a number of vessels left the fishery for other opportunities on the west coast, Gulf of Alaska or Bering Sea. Specifically, five of the larger vessels left for various Alaskan crab fisheries. While there will probably be new entrants into the NWHI lobster fishery in 1987, at the end of 1986, catches appear to have leveled, and although demand for lobster tails is up, present participants in the fishery appear to be looking elsewhere for opportunities.

RESEARCH

Stock Assessment

In 1986 both commercial and research data were used to assess the status of the spiny and slipper lobster stocks of the NWHI. Most of the information presented here is from Polovina, Moffitt, and Clarke (1987). In the summer of 1986, the SWFC Honolulu Laboratory undertook the second annual standardized lobster assessment cruise. Three banks (Maro, Necker, and Laysan), were fished with 2 x 4 in wire mesh, two-chambered, California style traps. This type of gear was used when the SWFC Honolulu Laboratory initially started trapping for lobster in the NWHI before commercial exploitation began in the NWHI. Because all of the early baseline CPUE data was based on wire traps, the sampling was continued in 1985 and 1986 to eliminate the problems associated with commercial CPUE figures which are derived from traps with different catchability coefficients.

The 1986 cruise results indicated trapable spiny lobster were 33, 53, and 56% of 1977 levels at Necker, Maro, and Laysan, respectively. The decline is statistically significant at Necker and Maro, while not at Laysan (due to the high variability of catch rates within sampling during 1977 and 1986).

The study then divides the spiny lobster into harvestable (above 77 mm carapace length (CL)) and subharvestable (those between 70 and 77 mm CL) size-classes. This is because the wire traps tend not to catch many lobster below 70 mm and lobster between 70 and 77 mm CL are pre-recruits. In 1986 at Maro Reef and Necker Island, the standardized catch rate for harvestable size lobster was 49 and 22%, respectively, of unexploited levels in 1977. Catch rates declined from 1985 to 1986, but were not statistically significant. The catch rate of subharvestable lobster was 48 and 85% of 1977 levels in 1986 at Necker Island and Maro Reef. The decline in subharvestable lobster was statistically significant at Necker Island but not at Maro Reef.

They found that at Necker Island, female spiny lobster are now first bearing eggs at a significantly smaller size than they were in 1977. The size of the onset of sexual maturity for female lobster can be defined as the size where the ratio of egg bearing females to total females is one-half the value for large females. Female lobster trapped during the assessment cruise were examined for the presence of external eggs, and this was used as an index of sexual maturity. By first determining the size at which the ratio of egg bearing females to total females is one-half the

value for large females, the study found that at Maro Reef, the size of onset of sexual maturity was 7.6 cm CL or 5.2 TW_3 (tail width measuring site three). At Necker Island, which has historically had smaller lobster, the onset of sexual maturity was 6.6 cm CL or 4.6 cm TW_3. When the data from the last two assessment cruises were pooled (there was no significant difference between 1985 and 1986 sexual maturity indices), it was found that at Necker Island, the onset of sexual maturity had declined significantly, while it had not at Maro Reef. This information indicated that the spiny lobster population at Necker Island appears to be responding to fishing pressure by lobster bearing eggs at a smaller size. Also, the possibility exists that a greater fraction of the females were bearing eggs at any one time in 1985 and 1986 compared to 1977. Catch rates were converted to weight per trap-night, and using the estimates of size of the onset of sexual maturity, an estimate of female spawning biomass was calculated. It was found that in 1986, female spawning stock biomass was at 36 and 58% of its 1977 levels at Necker Island and Maro Reef. Both declines are statistically significant.

CPUE Analysis

With the fishery changing so dramatically since the inception of the FMP in 1983, an effort was made to better understand current CPUE statistics. The commercial catch data reports both spiny and slipper lobster catches, but reports only the total trapping effort for all lobster catches rather than specifically the fishing effort which targets each species separately. A standardized measure of spiny lobster fishing effort was calculated to better compare 1983 statistics with 1986.

Using standardized effort and catch statistics for 1986, the study found that the Maro Reef fishery in 1986 is near an equilibrium maximum sustainable yield (MSY) of 350,000 legal spiny lobster while the entire NWHI fishery was at MSY of 896,000 legal spiny lobster. At Necker Island, yield reached a maximum in 1984 and has declined since that time. The yield curve suggests that at Necker Island, fishing effort is excessive and yield is below optimum. However, the entire NWHI lobster fishery current yield is sustainable, and effort is near optimum for spiny lobster.

Capture and release mortality due to handling of sublegal lobster are cited as being partially responsible for declining yield, especially at Necker Island. Fishing induced mortalities to subharvestable lobster will later be reflected by declining CPUE in subsequent years, and predictions that 1987 CPUE will continue downward were made. Escape vents are cited as one possible solution to halt the declining CPUE.

Slipper lobster assessment proves difficult due to nonequilibrium conditions. The fishery has only been heavily exploited since 1984 and at present, has no regulations on fishing beside mandated release of berried females. However, if 1985-86 landings are considered exploitation of a relatively virgin biomass and current levels of fishing mortality are optimal, then one-half of the average annual landings for 1985 and 1986 (approximately 600,000 lobsters) is felt to be a preliminary estimate of

sustainable yield. Combined with a MSY estimate of 900,000 for spiny lobster and that for slipper lobster, the NWHI lobster fishery can sustain yearly catches of 1.5 million lobster, all other factors being equal. In 1986 combined spiny and slipper lobster landings were 2.1 million lobster, 42.2% above estimated combined MSY.

Escape Gaps

Laboratory tank experiments and commercial field trials took place in 1986 to determine the relative effectiveness of different escape vent sizes and configurations. In 1985 a rectangular vent was determined to be effective in releasing sublegal spiny lobster while not affecting legal spiny lobster catch rates. Unfortunately, the initial research did not include slipper lobster, even though it was suggested that slipper lobster escapement would be a problem. Both field and tank trials of rectangular escape vent confirmed substantial loss of slipper lobster and a better alternative was sought in light of its growing economic importance.

In March and April 1986, laboratory tank trials were run to determine the relative effectiveness of both circular and rectangular escape vents on slipper and spiny lobster escapement. At that time, circular escape vents proved to be a potentially viable alternative to the escapement problem of slipper lobster in rectangular vented traps.

A range of both circular and rectangular sized escape vents was chosen to be tested under commercial conditions. One of the larger commercial lobster vessels participated in the gear trials which took place between August and November 1986. Small mesh, black plastic traps, modified with rectangular and circular vents, were supplied to the vessel along with a NMFS researcher. The size of the vents was selected to provide a range of retention sizes which would cover the minimum legal spiny lobster TW and a range of proposed minimum slipper lobster TW (5.2 cm to 5.6 cm) (Polovina, Everson, and Kazama 1987). The experimental gear was fished alongside the vessel's regular gear at the discretion of the vessel's captain .

The field trials proved successful with over 8,000 spiny and 13,000 slipper lobsters caught in the NMFS experimental traps. In general the vented traps substantially reduced the number of sublegal spiny and small slipper lobsters caught in the traps. The catch rate of legal spiny and medium to large slipper lobsters in the vented traps was not statistically different from control traps in many cases. The circular vents proved to perform better than the rectangular vents. However, which circular vents work best depends on the size of slipper lobster chosen for escapement. The study provides for a wide range of possible minimum sizes for slipper lobster and the effects on legal spiny lobster catch rate. A predictive equation for slipper lobster catch rate between traps with circular vented and control traps has been determined in the eventuality there is need for interpolation of the results. Similarly, an equation is provided for predictions on the combined catch rate of slipper and spiny lobsters. Results indicated that the use of escape vents could potentially contribute $250,000 annually to the spiny lobster fishery. It could also provide

substantial benefit to the slipper lobster fishery by contributing to increased spawning biomass and reduce sorting work by the vessels.

Slipper Lobster Biology

In 1986, common slipper lobster morphometrics were examined in detail by NMFS personnel at the request of the WPRFMC. The WPRFMC was at that time formulating management strategies for the common slipper lobster. Essential to this management scheme was the development of a minimum size regulation for protection of spawning stock biomass. The intent of the minimum size regulation is to prevent recruitment overfishing.

The initial minimum size recommendation was calculated using data obtained on RV Townsend Cromwell research cruises. The standard measurement taken for slipper lobster was CL, along with TW. Therefore, it was necessary to determine the relationship between CL and TW, because TW is the industry standard.

A total of 1,655 slipper lobster were used in the analysis; all were caught at Maro Reef and Necker Island between 1984 and 1985 on three different Townsend Cromwell cruises. The linear regression equation and statistics for the pooled data were:

$$TW = 0.7606 * CL - 0.647$$

$$n = 1,655 \; R^2 = 0.953$$

The linear regression with log transformation on the same data gave a power function of:

$$TW = 0.71637 * CL^{1.01117}$$

$$n = 1,655 \; R^2 = 0.955$$

The variable of sex was also examined in the regression analysis. However, the results of separate equations for each sex revealed no difference due to sex. The female to male ratio was 46:54. Table 7 gives TW values for six different CL using the above equation.

In July 1986, the slipper lobster tail weight-tail width relationship was examined, again at the request of the WPRFMC, to get a better understanding of what the recommended minimum size would mean to fishermen in the way of lost tail sizes in weight.

Data were collected from six commercial vessels representing a full spectrum of vessels in the fleet. The vessels sampled represented both large and small components of the active fleet and discussions with vessel

personnel indicated several methods of processing lobster. The lobster sampled were caught at Necker Island, French Frigate Shoals, Brooks Banks, St. Rogatien Bank, Gardner Pinnacles, and Maro Reef between 1985 and 1986. Frozen lobster tails were sampled on the vessel if space allowed or at processing houses before being reprocessed. Tails widths ranged from 43.3 to 83.7 mm, and tail weights ranged from 40 to 320 g (1.4 to 11.3 oz) with a mean of 150.6 g or 5.3 oz.

The linear regression equation and statistics are presented below:

$$\text{Tail weight (grams)} = 7.1241 * \text{Tail width (millimeters)} - 298.51$$

$$n = 423 \qquad R^2 = 0.944$$

The linear regression was also performed on the same data after natural log transformation, yielding the power function:

$$\text{Tail weight (grams)} = 0.0005932 * \text{TW (millimeters)}^{2.98797}$$

$$n = 423 \qquad R^2 = 0.961$$

Table 8 gives the tail width-tail weight relationship in both grams and ounces.

The results are a general guideline, considering the amount of variability in processing methods from vessel to vessel as well as biological variability in the lobsters themselves. However significant each factor, this sample is felt to be representative of the fleet as a whole and not any one particular sector.

Economic Research

In 1986, a cooperative research project on the economics of commercial lobster fishing in the NWHI was initiated with SWFC Honolulu Laboratory, the WPRFMC, and the University of Hawaii College of Tropical Agriculture. The project involves four subparts: 1) a report on the dynamics and fishing patterns in the NWHI lobster fishery, 2) a survey of wholesale lobster dealers and brokers on the mainland U.S., 3) a cost-earnings study of the commercial fishing sector, and 4) a report on the potential economic effects of limited entry management. The first part of the study is presented in the "Dynamics of fleet composition and vessel fishing patterns in the NWHI commercial lobster fishery: 1983-1986" by P. D. Gates of the WPRFMC and K. C. Samples of the University of Hawaii. The second part is reported in "Market situation and outlook for NWHI spiny and slipper lobster" by Samples and Gates and is in the final review process. The third part, the cost-earnings study, is underway in the SWFC Honolulu

Laboratory, while the fourth part on the optimal configuration of the lobster fleet has just been initiated.

The fleet dynamics and fishing patterns study by Gates and Samples analyzes NWHI lobster fishing permits and Daily Lobster Catch Reports to document fleet activity in the fishery from 1983 through into 1987. In 1986, 51 NWHI lobster permits were documented compared to 11 in 1983. Gates and Samples' report concentrates on the growth of the fishery from 3 vessels fishing in 1983 to 19 by 1986. The report documents only four "active" vessels having exited the fishery since 1983. Also documented are increased average trip length and average fishing days per trip. Trip statistics show a trend toward greater dispersion along the NWHI range since FMP inception.

In the second study, Samples and Gates look at worldwide and domestic production and consumption of lobster and consider market conditions for the next few years. Marketing arrangements between vessels and wholesalers are identified, and recommendations are made to enhance lobster marketing efforts. United States mainland wholesalers were surveyed to discover their opinions on the lobster products presently being exported by NWHI fishermen.

Other Research

Several other reports were completed by the SWFC Honolulu Laboratory including: "Summary of worldwide research on lobster escape vents" and "Closed season as a management policy in lobster fisheries," both by A. R. Everson (1986a, 1986b), and "Estimation of minimum tail width size for legal spiny lobster in the Northwestern Hawaiian Islands fishery" by R. A. Skillman and J. P. Thomason (1986).

Two manuscripts were published by C. D. MacDonald of the State of Hawaii's Office of Ocean Resources on spiny lobster recruitment: "Oceanographic climate and Hawaiian spiny lobster larval recruitment" (1985) and "Recruitment of the puerulus of the spiny lobster, Panulirus marginatus, in Hawaii" (1986).

COUNCIL PLANNING TEAM ACTIVITIES

Planning Team Action - P. D. Gates

The Crustacean Plan Monitoring Team (CPMT) formally met eight times during the last year. Those meetings produced a number of recommendations to the WPRFMC.

After several years of fishing under the FMP, it was clear that additional specific information on the permit application was desirable. The information which the team recommended be included on permit applications would promote a more accurate assessment of fleet fishing

power and enable a more thorough monitoring of the economic condition of the fishery.

The CPMT also addressed refuge areas. As originally worded, the refuge areas explicitly named only spiny lobsters. Early last year, the CPMT suggested amending the Lobster FMP to read that no fishing for lobsters of any kind be allowed within designated refuges. That would close an unintended loophole which permitted fishing for slipper lobsters within those areas. This recommendation was packaged in Amendment 4 to the Lobster FMP and became effective March 1987.

Because the fishery has evolved into a multispecies fishery, the CPMT recommended a more thorough reporting of the commercially important catch. Specifically, the Team felt that all three harvested species of slipper lobster should be reported using the same format presently used for reporting catches of spiny lobster. Additionally, since the lobster fishery harvests a substantial amount of octopus as a by-catch, the CPMT also recommended that fishermen report their catch of octopus.

The principle issue considered by the CPMT throughout the past year was conservation of lobster stocks, slipper as well as spiny, in order to ensure future harvests. A number of alternatives, including area and seasonal closures were discussed extensively. The CPMT judged that a measure which allowed escapement of sublegal-sized lobsters would be the most effective. However, the practicability of this measure was contingent upon selection of a minimum legal size for slipper lobsters. After considerable research and discussion, the CPMT suggested that the WPRFMC adopt a TW of 5.6 cm (as measured at the top of the notch between the first and second tail segments) as a minimum legal size for the common slipper lobster, Scyllarides squammosus. The 5.6 cm TW recommendation was based on both biological and economical rationales. Escape vent trials were conducted and evaluated with this minimum size in mind. It was found that circular escape vents 67 mm in diameter performed remarkably well for both slipper and spiny lobsters in light of the required criteria. Thus, the Planning Team recommended 5.6 cm as the minimum legal size for slipper lobster, and that traps be equipped with 67 mm diameter circular escape vents.

The recommendations outlined, with the exception of those concerning refuge areas, will be incorporated in Amendment 5 to the Lobster FMP.

Council Action

During 1986 the WPRFMC approved two amendments to the Spiny Lobster FMP and initated one emergency regulation. Amendment 3 to the Spiny Lobster FMP went into effect on April 6, 1986, and was intended to replace unenforceable spiny lobster size limits with a different approach for measuring a legal size spiny lobster. As such, Amendment 3: 1) eliminated the 7.7 cm CL to define a legal size spiny lobster and established a 5.0 cm minimum TW measurement in its place, 2) established a new site for

measuring TW, and 3) eliminated the 15% tolerance for sublegal spiny lobsters.

In October 1986 the WPRFMC implemented an emergency regulation to prohibit all lobster fishing within 20 nmi of Laysan Island and within the exclusive economic zone (EEZ) landward of 10 fathoms in the NWHI. The emergency regulation was initiated to protect the integrity of refuge areas in the NWHI established by the FMP. Designated refuge areas (refugia) in the NWHI were closed to spiny lobster fishing for the purpose of aiding lobster recruitment, providing a control area for stock assessment research, and protecting endangered monk seals. The rapid growth of a directed slipper lobster fishery in the NWHI, however, created a potential enforcement problem for the refugia where regulations specifically prohibited fishing for spiny lobsters only. In order to carry out the intent of the FMP to provide a total refuge for spiny lobsters in the designated refugia, an emergency regulation to prohibit fishing for all lobsters in the refugia, including slipper lobsters, was implemented.

ENDANGERED AND THREATENED SPECIES INTERACTIONS

The Daily Lobster Catch Reports are also the means for reporting monk seal and turtle sightings or interactions in the lobster fishery (Table 9). In 1986 fishermen hauled gear on 2,166 "vessel days" and reported sighting monk seals on 80 different occasions. Monk seals were reported in the vicinity of the gear on nine different occasions and were observed eating released lobster on five occasions.

A monk seal mortality was reported for the first time in 1986. An immature male apparently became entangled in the groundline and bridle of a string of gear and drowned. The incident occurred at Necker Island and there was no NMFS tag on the animal. The animal was released dead after being untangled from the gear. The NMFS is investigating the situation to further understand the incident and make recommendations to avoid future monk seal mortalities by lobster fishing gear in the future.

Necker Island had the greatest number of sighting and interactions in 1986, followed by Nihoa Island and Gardner Pinnacles. On two different occasions, monk seals with NMFS tags were sighted at Raita Bank. The number of sightings and interactions are not considered to be an accurate quantitative indicator of abundance because some fishermen apparently take more time than others to log occurrences.

Turtle sightings were noted in the vicinity of lobster gear on 18 different occasions with Nihoa and Necker Islands both having 4 reported sightings. The other 10 sightings were reported at 5 different areas.

LABORATORY RECOMMENDATIONS

The 1985 Annual Report contained nine formal recommendations from the SWFC Honolulu Laboratory concerning research and management of the NWHI

lobster fishery. All of these recommendations were met at least in part during 1986. Four recommendations pertained to regulation of slipper lobsters, and these were implemented by the WPRFMC at its March 1987 meeting. One recommendation pertained to requiring escape gaps, and this too was approved by the WPRFMC in March 1987. Improved economic information was implemented by Amendment 5, March 1987.

The annual lobster stock assessment cruise is scheduled to take place in June 1987. Its general survey protocols are expected to be similar to previous cruises, although some thought is being given to redirecting sampling effort. Because of the low density of spiny lobsters at Laysan Island, baseline estimates derived from Laysan are statistically inefficient. This could be solved by increased sampling power, either at the expense of sampling elsewhere, or through sampling Laysan on alternate years. Additional sampling of juvenile lobsters in an attempt to create a predictive time-series is also being considered. This type of data is considered more reliable than use of puerulus collectors. Finally, juvenile habitat may also be explored as part of the SWFC Honolulu Laboratory's general habitat research program.

Two recommendations from 1986 appear to be inappropriate this year: improved size composition coverage of lobster landings and annual placement of an observer on commercial lobster vessels to obtain at-sea size composition measurements. Shoreside monitoring of size composition through random sampling of the catch is no longer feasible since almost all vessels sort their catch at sea. At-sea monitoring, while useful, is expensive. However, should problems arise with the size composition which are not addressed by the recording of legal and sublegal numbers on the log books, then at-sea monitoring would be reconsidered.

SUMMARY

1. Most of the fishing regulated by the lobster management plan took place in the NWHI; there were 58 trips made to the NWHI and 2 trips in the vicinity of the MHI.

2. In 1986, 521 t of spiny lobster products (wet weight) were valued at $3.7 million, while slipper lobster products rose to an all time high of 484 t valued at $2.3 million (ex-vessel price).

3. Logbooks indicate that 896,407 legal spiny lobster and 1,359,795 total spiny lobster were caught in 1986. In addition, 1,237,527 total slipper lobster were reported caught in 1986, the highest catch on record.

4. The three most important fishing grounds for spiny lobster in descending order were Maro Reef, Necker Island, and St. Rogatien Bank. For slipper lobster in descending order were Maro Reef, Brooks Banks, and Gardner Pinnacles.

5. A total of 16 federally permitted vessels took 60 trips and fished 1,455,790 trap-nights in both the NWHI and the MHI. In 1986 effort was

greatest (in trap-nights) at Maro, Necker, and Gardner Pinnacles, respectively.

6. The catch rate for legal spiny lobster continued to decline from 0.88 in 1985 to 0.62 in 1986. The total spiny lobster CPUE declined from 1.31 in 1985 to 0.93 in 1986. The total slipper lobster CPUE declined from 1.09 in 1985 to 0.85 in 1986.

7. Escape vent research indicates that two circular panels placed on the lower portion of the trap allow for relatively high sublegal spiny and slipper lobster escapement and should provide significant long-term economic and biological benefit to the fishery.

8. The spiny lobster stocks appear to be in stable biological condition however, heavily exploited on certain banks. Slipper lobster stocks have been heavily fished in just the last 2 years and it is expected that the CPUE will continue to decline.

ADMINISTRATIVE AND ENFORCEMENT ACTIVITIES

The year 1986 marked the fourth year of enforcement of regulations since the spiny lobster management plan was implemented in March 1983. In 1986 a record number of vessels were issued permits for the spiny lobster fishery, however, the total number of vessels which actually participated in the fishery remained constant. Reported violations of lobster regulations decreased in 1986, however, enforcement agents posted an increase in the number of violations for failure to submit a lobster sales report.

The first reported Hawaiian monk seal fatality to occur incidentally to the spiny lobster fishery took place in November 1986 in the vicinity of Necker Island. An investigation was conducted wherein it was determined that the monk seal was killed as a result of entanglement in a trap bridle line and mainline on a night of large ground swells which caused extensive gear entanglement and the loss of several traps. Inasmuch as the fatality was the first such incident in over 3 million trap-nights, it was determined by the Southwest Region Director to be a rare occurrence for which no further action was required. The Southwest Region Director, however, intends to monitor the lobster fishery closely for any further interaction with Hawaiian monk seals.

Permits to Fish

A record 54 vessels were issued permits for the lobster fishery in calendar year 1986. This compares with 45 permits issued in 1985, 19 issued in 1984, and 14 issued in 1983. The total trap carrying capacity for permitted vessels in 1986 was 37,549. Of the 54 vessels permitted, only 3 requested permits to fish in permit area 2, the EEZ around the MHI. All the others were permitted for the NWHI permit area 1. No permits were issued for permit area 3, the EEZ around American Samoa and Guam.

Despite the record number of permits issued in 1986, only 16 vessels actively participated in the fishery. This is identical to the number of vessels that participated in the fishery in 1985. Of the 16 vessels actively engaged in the fishery in 1986, 5 were new entrants to the fishery and 11 vessels were carryover from the 1985 active fleet. The 16 vessels active in 1986 carried a total of 13,580 traps. This represents a slight increase from the 12,250 traps carried by the active fleet in 1985 (Table 10).

Enforcement Activities and Violations

In 1986 NMFS enforcement agents inspected 28 landings of lobsters all in Honolulu. In addition, U.S. Coast Guard (USCG) patrol vessels boarded five lobster vessels at sea. A total of nine violations were reported for which agents issued six verbal warnings and three Enforcement Action Reports. The 9 violations in 1986 compare to 22 violations reported in 1985. Of the nine violations reported, three involved a failure to submit a lobster sales report, three vessels were cited for retaining sublegal lobsters, two vessels were cited for failure to report their Honolulu arrival time 24 h in advance, one vessel was cited for failure to maintain accurate logs. In addition, there is one case pending concerning fishing for spiny lobsters in a closed area. A summary of 1986 enforcement actions in contained in Table 11.

Enforcement Problems

The implementation of Amendment 3 to the Spiny Lobster FMP eliminated the confusion inherent in a 15% tolerance limit for sublegals and also eliminated the impractical requirement for enforcement agents to obtain a random sample from a vessel's catch. Enforcement of the minimum size regulation has been greatly simplified as a result of Amendment 3 and appears to be well accepted by the lobster fishing industry.

The problem with lobster vessels failing to report their arrival time 24 h in advance, which had plagued NMFS agents and the USCG in previous years, has been resolved largely through efforts to improve communication links between the USCG and arriving lobster vessels.

The requirement that fishermen maintain complete and accurate fishing logs continues to be a difficult one to enforce. Until such time as a means of cross-checking logbook records can be implemented, only the most flagrant and erroneous logging violations can be detected.

In 1986 NMFS agents reported three violations for failure to submit lobster sales reports. This is the only area in which the number of violations increased from 1985. In 1985 only one such violation was reported.

As participation and competition in the lobster fishery grow, an increase in gear conflicts is likely given the limited areas trageted by

lobster fishermen. In view of this potential problem, consideration should be given to requirements for owner markings on lobster gear.

RECOMMENDATIONS

1. The Southwest Region (SWR) recommends that the WPRFMC restructure the Spiny Lobster FMP as a framework plan to allow more timely response to changes in the fishery. A framework approach will give the WPRFMC greater flexibility in managing the fishery without having to promulgate emergency regulations or rely on the lengthy plan amendment process.

2. The SWR recommends that the WPRFMC continue to monitor the lobster fishery and evaluate the effectiveness of current management measures. The WPRFMC may also wish to consider other management options such as catch quotas and access management for the lobster fishery.

3. The SWR recommends that the WPRFMC consider holding an annual information meeting with the lobster industry to discuss problems in the fishery and possible management needs. Such meetings would lead to improved communications with the lobster industry and might uncover issues or problems the WPRFMC might otherwise have missed.

4. The SWR recommends that studies or reports related to the lobster fishery be distributed to industry participants on a timely and regular basis.

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Table 1.--Estimated annual sales of spiny and slipper lobsters. Ex-vessel price is in dollars per pound and ex-vessel revenue is in dollars. Weight is in terms of whole animals as is ex-vessel price. See text for source of data.

Year	Spiny lobster				Slipper lobster				No. of vessels	No. of trips
	Pounds (whole)	Metric tons	Price (whole $/lb)	Revenue	Pounds (whole)	Metric tons	Price (whole $/lb)	Revenue		
1977	72,000	30	2.90	209,000	--	--	--	--	5	14
1978	45,000	20	3.00	135,000	--	--	--	--	2	12
1979	100,000	50	3.20	320,000	--	--	--	--	2	6
1980	328,000	150	3.40	1,115,000	--	--	--	--	3	12
1981	780,000	350	3.50	2,730,000	--	--	--	--	10	25
1982	187,000	80	3.60	673,000	--	--	--	--	7	19
1983	[1]203,000	90	2.91	591,000	--	--	--	--	4	19
1984	[1]935,000	425	2.66	2,490,000	[2]220,000	100	1.64	361,000	11	38
1985	[1]1,438,000	654	2.94	4,227,000	[2]930,000	423	1.78	1,660,000	16	62
1986[3]	[1]1,146,000	521	3.23	3,701,000	[2]1,065,000	484	2.15	2,296,000	16	60

[1] Includes frozen tail weight expanded to represent whole weight (tail weight = 35.6% of whole weight).

[2] Includes frozen tail weight expanded to represent whole weight (tail weight = 33.3% of whole weight).

[3] Preliminary estimate.

Table 2.--Estimated annual sales of spiny and slipper lobster by product type. Ex-vessel price is in dollars per pound and ex-vessel revenue is in dollars.

			Spiny lobster				Slipper lobster					
Year	Product	Type	Pounds	Metric tons	Price	Revenue	Pounds	Metric tons	Price	Revenue	No. of vessels	No. of trips
1977	Live		72,000	33	2.90	208,800	--	--	--	--	5	14
1978	Live		45,000	20	3.00	135,000	--	--	--	--	2	12
1979	Live		100,000	45	3.20	320,000	--	--	--	--	2	6
1980	Not available											
1981	Not available											
1983[1]	Live		25,000	11	4.46	111,600	--	--	--	--	4	12
	Frozen	Whole	15	0	4.00	60	--	--	--	--	1	1
	Frozen	Tails	51,400	23	7.41	380,800	--	--	--	--	2	7
1984[2]	Live		36,500	17	4.70	171,700	--	--	--	--	7	9
	Frozen	Whole	3,500	2	3.98	13,800	100	--	3.00	400	3	6
	Frozen	Tails	318,600	145	7.23	2,304,500	27,300	12	4.92	134,000	10	31
1985[2]	Live		35,200	16	4.71	165,800	30	--	3.90	100	7	21
	Frozen	Whole	2,800	1	4.08	12,800	600	--	2.73	1,600	3	8
	Frozen	Tails	498,000	226	8.13	4,050,000	310,000	141	5.35	1,660,000	15	56
1986[3]	Live		18,200	8	5.11	92,900	100	--	5.25	600	6	15
	Frozen	Whole	15,400	7	3.84	59,500	3,570	2	3.00	10,700	6	9
	Frozen	Tails	396,000	180	8.96	3,549,000	353,000	160	6.46	2,284,000	16	54

[1]March through December 1983.

[2]The 1984 and 1985 figures are revised from the 1985 annual report.

[3]Preliminary figures representing 54 sales and processing trip reports for spiny lobster and 38 for slipper lobster.

Table 3.--Annual catch in numbers of spiny lobster, Panulirus marginatus, slipper lobsters, Scyllarides sp., and kona crab, Ranina ranina, by vessels in the Northwestern Hawaiian Island lobster fishery. FFF = French Frigate Shoals; LI = Lisianski Island; NH = Northampton Seamount; PH = Pearl and Hermes Reef; SR = St. Rogatien; MHI = Main Hawaiian Islands.

Year	Area	No. of vessels	No. trip	Legal spiny	Sublegal spiny	Berried spiny	Total spiny	Total slipper	Kona crab
1983	Gardner	1	2	23,686	1,206	364	25,256	2,888	0
	Maro	1	1	27,210	1,426	638	29,274	8,990	0
	Necker	4	18	111,710	48,148	8,710	168,668	13,732	3
	Total	4	19	157,606	50,780	9,712	218,198	25,610	3
1984	FFS	1	1	266	42	23	331	166	0
	Gardner	5	10	174,274	9,059	5,836	189,169	109,264	192
	Maro	3	7	250,489	20,789	16,329	287,607	83,855	0
	Necker	10	24	210,494	206,919	40,765	458,178	77,401	355
	Nihoa	3	8	24,174	1,531	11,213	36,918	12,993	202
	Raita	2	3	7,586	137	84	7,807	1,134	0
	MHI	1	1	9	2	1	12	2	0
	Total	11	38	667,292	238,479	74,251	980,022	284,815	749
1985	Brooks	3	5	21,486	5,669	4,865	32,020	55,843	1
	FFS	3	4	10,011	2,462	1,172	13,645	5,306	10
	Gardner	8	13	96,484	15,354	10,289	122,127	212,528	141
	Kure	4	5	14,159	1,057	2,021	17,237	7,396	283
	LI	3	3	36	10	14	60	840	0
	Maro	7	18	359,949	53,874	41,200	455,023	538,288	33
	Necker	12	35	185,654	212,970	32,440	431,064	154,464	140
	Nihoa	2	5	7,949	478	699	9,126	6,530	5
	NH	3	3	110	8	16	134	1,417	0
	PH	4	6	49,960	9,659	2,252	61,871	40,466	11
	Raita	4	5	9,583	644	295	10,522	5,468	0
	SR	4	7	200,054	42,308	33,954	276,316	161,030	2
	Other (1)	2	2	186	9	0	195	25	0
	MHI	2	3	421	109	186	716	241	9
	Total	16	62	956,042	344,611	129,403	1,430,056	1,189,842	635

Table 3.--Continued.

Year	Area	No. of vessels	No. trip	Legal spiny	Sublegal spiny	Berried spiny	Total spiny	Total slipper	Kona crab
1986	Brooks	3	8	27,472	4,650	2,004	34,126	113,036	26
	FFS	6	7	66,640	30,711	13,519	110,870	23,681	31
	Gardner	8	14	86,556	16,209	14,183	116,908	94,002	92
	LI	4	4	1,827	93	170	2,090	26,212	0
	Maro	12	25	350,234	104,886	65,583	520,703	476,671	190
	Necker	8	19	173,785	119,252	38,973	332,010	84,382	2
	Nihoa	5	8	5,272	246	3,902	9,420	29,131	828
	Raita	6	8	52,039	6,430	5,572	64,041	78,948	25
	SR	3	7	117,156	21,469	9,441	148,066	90,596	1
	Other	4	4	14,622	1,528	1,466	17,616	220,552	51
	MHI	1	2	804	2,390	751	3,945	316	8
	Total	16	60	896,407	307,864	155,564	1,359,795	1,237,527	1,254

Includes those areas that were fished by less than three different vessels. These include Northampton Seamount, Pioneer Bank, Pearl and Hermes Reef, Midway, Kure Atoll, an unnamed bank north of St. Rogatien Bank, and Laysan Island.

Table 4.--Percent of total slipper and spiny lobster in the total catch of all lobster, by island and year.

Year	Area	Total spiny lobster	Total slipper lobster
1983	Gardner	89.7	10.3
	Maro	73.0	27.0
	Necker	92.5	7.5
	Total	89.5	10.5
1984	French Frigate Shoals	66.6	33.4
	Gardner	63.4	36.6
	Maro	77.4	22.6
	Necker	85.5	14.5
	Nihoa	74.0	26.0
	Raita	87.3	12.7
	Main Hawaiian Islands	85.7	14.3
	Total	77.5	22.5
1985	Brooks Banks	36.4	63.6
	French Frigate Shoals	72.0	28.0
	Gardner	36.5	63.5
	Kure	70.0	30.0
	Lisianski	6.7	93.3
	Maro	45.8	54.2
	Necker	73.6	26.4
	Nihoa	58.3	41.7
	Northampton	8.6	91.4
	Pearl and Hermes Reef	60.5	39.5
	Raita	65.8	34.2
	St. Rogatien	63.2	36.8
	Other (1)	88.6	11.4
	Main Hawaiian Islands	74.8	25.2
	Total	54.6	45.4
1986	Brooks Banks	23.2	76.8
	French Frigate Shoals	82.4	17.6
	Gardner	55.4	44.6
	Lisianski	7.4	92.6
	Maro	52.2	47.8
	Necker	79.7	20.3
	Nihoa	24.4	75.6
	Raita	44.8	55.2
	St. Rogatien	62.0	38.0
	Others (7)	7.4	92.6
	Main Hawaiian Islands	92.6	7.4
	All	52.4	47.6

Table 5.--Annual fishing effort and catch per trap-night, using date of landing for spiny lobster, slipper lobster, and kona crab by vessels in the Northwestern Hawaiian Islands by area. Derived from FMP required "Daily lobster catch report per statistical area."

Year	Area	No. of days	No. of trap-nights	Catch per trap-night					
				Legal spiny lobster	Sublegal spiny lobster	Berried spiny lobster	Total spiny lobster	Total slipper lobster	Kona crab
1983	Gardner	29	12,916	1.83	0.09	0.03	1.96	0.22	0.00
	Maro	36	16,150	1.38	0.09	0.04	1.50	0.56	0.00
	Necker	209	47,791	2.34	1.01	0.18	3.53	0.29	0.00
	Overall	274	76,857	2.05	0.66	0.13	2.84	0.33	0.00
1984	Gardner	192	102,099	1.71	0.09	0.06	1.85	1.07	0.00
	Maro	247	142,973	1.75	0.15	0.11	2.01	0.59	0.00
	Necker	294	97,509	2.16	2.12	0.42	4.70	0.79	0.00
	Nihoa	73	23,871	0.01	0.06	0.47	1.55	0.54	0.01
	Others (2)	14	10,938	0.72	0.02	0.01	0.74	0.12	0.00
	MHI	2	50	0.18	0.04	0.02	0.24	0.04	0.00
	Overall	822	377,440	1.17	0.63	0.20	2.60	0.75	0.00
1985	Brooks	40	30,428	0.71	0.19	0.16	1.05	1.84	0.00
	French Frigate	28	15,026	0.67	0.16	0.08	0.91	0.35	0.00
	Gardner	245	163,038	0.59	0.09	0.06	0.75	1.30	0.00
	Kure	25	15,728	0.90	0.07	0.13	1.10	0.47	0.02
	Lisianski	3	1,265	0.03	0.01	0.01	0.05	0.66	0.00
	Maro	467	371,854	0.97	0.14	0.11	1.22	1.45	0.00
	Necker	435	211,243	0.88	1.01	0.15	2.04	0.73	0.00
	Nihoa	28	13,405	0.59	0.04	0.05	0.68	0.49	0.00
	Northampton	3	1,330	0.08	0.01	0.01	0.10	1.07	0.00
	Pearl and Hermes	104	65,907	0.76	0.15	0.03	0.94	0.61	0.00
	Raita	28	11,869	0.81	0.05	0.02	0.89	0.46	0.00
	St. Rogatien	213	180,711	1.11	0.23	0.19	1.53	0.89	0.00
	Other (1)	2	498	0.37	0.02	0.00	0.39	0.05	0.00
	MHI	32	7,160						
	Overall	1,653	1,089,462	0.88	0.32	0.12	1.31	1.09	0.00

Table 5.--Continued.

Year	Area	No. of days	No. of trap-nights	Catch per trap-night: Legal spiny lobster	Sublegal spiny lobster	Berried spiny lobster	Total spiny lobster	Total slipper lobster	Kona crab
1986	Brooks	131	79,351	0.35	0.06	0.03	0.43	1.42	0.00
	French Frigate	99	69,450	0.96	0.44	0.19	1.60	0.34	0.00
	Gardner	233	182,677	0.46	0.09	0.08	0.64	0.51	0.00
	Lisianski	20	14,828	0.12	0.01	0.01	0.14	1.77	0.00
	Maro	670	491,316	0.71	0.21	0.13	1.06	0.97	0.00
	Necker	405	242,353	0.72	0.49	0.16	1.37	0.35	0.00
	Nihoa	70	31,504	0.17	0.01	0.12	0.30	0.92	0.00
	Raita	255	114,101	0.46	0.06	0.05	0.56	0.69	0.00
	St. Rogatien	179	139,126	0.84	0.15	0.07	1.06	0.65	0.00
	Others (7)	120	87,170	0.17	0.02	0.02	0.20	2.53	0.00
	MHI	30	3,914	0.21	0.61	0.19	1.01	0.81	0.00
	Overall	2,166	1,455,790	0.62	0.21	0.11	0.93	0.85	0.00

Table 6.--Monthly catch (in number) per trap-night, using date of landing of spiny lobster, slipper lobster, and kona crab by vessels in the Northwestern Hawaiian Islands. Derived from FMP-required "Daily catch report per statistical area."

Year	Month	No. of areas	No. of trap-nights	Catch per trap-night					
				Legal spiny lobster	Sublegal spiny lobster	Berried spiny lobster	Total spiny lobster	Total slipper lobster	Kona crab
1983	Mar.	1	960	2.19	1.04	0.39	3.61	0.25	0.00
	Apr.	1	8,091	1.46	0.27	0.11	1.84	0.16	0.00
	May	1	1,120	2.23	0.85	0.64	3.72	0.46	0.00
	June	1	5,205	1.83	0.76	0.16	2.75	0.42	0.00
	July	1	800	2.74	3.46	0.46	6.67	0.31	0.00
	Aug.	2	14,579	1.72	0.23	0.10	2.06	0.15	0.00
	Sept.	1	2,300	2.42	1.46	0.36	4.24	0.18	0.00
	Oct.	1	12,000	2.52	0.23	0.12	2.88	0.42	0.00
	Nov.	3	25,252	1.57	0.67	0.04	2.29	0.49	0.00
	Dec.	1	6,550	4.39	2.04	0.26	6.69	0.19	0.00
	Annual	3	76,857	2.05	0.66	0.13	2.84	0.33	0.00
1984	Jan.	0	--	--	--	--	--	--	--
	Feb.	2	12,768	1.16	0.74	0.06	1.96	0.36	0.00
	Mar.	3	14,658	2.73	1.22	0.18	4.13	1.09	0.00
	Apr.	4	53,167	1.79	0.16	0.15	2.10	0.75	0.00
	May	0	--	--	--	--	--	--	--
	June	2	10,360	1.76	1.73	0.65	4.14	0.57	0.00
	July	2	10,090	0.96	0.04	0.63	1.63	0.35	0.00
	Aug.	5	66,526	2.29	0.71	0.17	3.17	0.50	0.00
	Sept.	2	14,181	2.01	2.90	0.19	5.11	1.04	0.00
	Oct.	2	20,180	2.15	0.37	0.10	2.62	0.69	0.00
	Nov.	4	40,810	1.85	0.63	0.13	2.61	1.03	0.00
	Dec.	6	134,700	1.41	0.47	0.21	2.08	0.83	0.00
	Annual	7	377,440	1.77	0.63	0.20	2.60	0.75	0.00
1985	Jan.	3	18,106	0.80	0.23	0.09	1.12	0.31	0.00
	Feb.	3	27,652	0.76	1.02	0.17	1.96	0.65	0.00
	Mar.	6	55,312	0.80	0.55	0.07	1.42	0.87	0.00
	Apr.	10	141,393	0.41	0.12	0.03	0.56	1.41	0.00
	May	9	51,867	0.59	0.54	0.09	1.23	1.84	0.00
	June	5	119,655	0.74	0.30	0.11	1.16	2.60	0.00
	July	4	111,000	1.23	0.18	0.18	1.59	1.11	0.00
	Aug.	10	98,867	1.08	0.40	0.18	1.66	0.64	0.00
	Sept.	9	51,877	1.48	0.63	0.19	2.29	0.35	0.00
	Oct.	9	174,214	1.12	0.26	0.18	1.56	0.77	0.00
	Nov.	4	34,703	0.98	0.14	0.08	1.20	0.67	0.00
	Dec.	8	204,816	0.74	0.29	0.07	1.09	0.73	0.00
	Annual	18	1,089,462	0.88	0.32	0.12	1.31	1.09	0.00

Table 6.--Continued.

Year	Month	No. of areas	No. of trap-nights	Catch per trap-night: Legal spiny lobster	Sublegal spiny lobster	Berried spiny lobster	Total spiny lobster	Total slipper lobster	Kona crab
1986	Jan.	6	107,530	0.83	0.31	0.06	1.20	0.65	0.00
	Feb.	7	27,076	0.34	0.26	0.06	0.66	0.90	0.00
	Mar.	3	20,750	0.83	0.52	0.15	1.50	0.42	0.00
	Apr.	11	174,340	0.55	0.21	0.17	0.83	1.30	0.00
	May	4	67,791	0.23	0.21	0.08	0.52	0.90	0.00
	June	6	113,526	0.32	0.14	0.09	0.55	1.37	0.00
	July	12	152,455	0.42	0.06	0.12	0.60	1.68	0.00
	Aug.	9	177,825	0.67	0.14	0.10	0.90	0.66	0.00
	Sept.	3	115,622	1.13	0.36	0.17	1.65	0.35	0.00
	Oct.	3	82,578	0.61	0.23	0.19	1.02	0.51	0.00
	Nov.	6	247,847	0.80	0.24	0.10	1.13	0.65	0.00
	Dec.	8	168,450	0.44	0.22	0.12	0.78	0.44	0.00
	Annual	19	1,455,790	0.62	0.21	0.11	0.93	0.85	0.00

Table 7.--Tail width-carapace length relationship for common slipper lobster.

Carapace length	Tail width
64.0	48.0
66.6	50.0
70.0	52.6
72.5	54.5
75	56.4
80	60.2

Table 8.--Estimates of equivalent weight in grams and ounces for common slipper lobster, Scyllarides squammosus, tail widths. See Research--slipper lobster for discussion.

Tail width (mm)	Tail weight (g)	Tail weight (oz)
50	71	2.5
51	75	2.6
52	80	2.8
53	84	3.0
54	89	3.1
55	94	3.3
56	99	3.5
57	105	3.7
58	110	3.9
59	116	4.1
60	122	4.3
61	128	4.5
62	135	4.7
63	141	5.0
64	148	5.2
65	155	5.5
66	162	5.7
67	170	6.0
68	177	6.3
69	185	6.5
70	193	6.8
71	202	7.1
72	210	7.4
73	219	7.7
74	228	8.1
75	238	8.4
76	247	8.7
77	257	9.1
78	267	9.4
79	277	9.8
80	288	10.2

Table 9.--Reported sightings and interactions with endangered or threatened species in the Northwestern Hawaiian Islands lobster fishery.

Island	Individuals				
	1	2	3	4	5
Monk seals observed in statistical area					
Brooks	5				
French Frigate	2				
Gardner	4	6	3	1	
Maro	1				
Necker	13	7	4		1
Nihoa	10	8			
Pearl and Hermes	1				
Raita	[1]4				
St. Rogatien	8	2			
Monk seals observed in vicinity of fishing gear					
Brooks	2				
French Frigate	2				
Gardner	1				
Raita	4				
Monk seals observed preying on released lobster					
Gardner	1				
Necker	3	1			
Monk seals entangled and released dead					
Necker	1				
Turtles observed in vicinity of fishing gear					
Gardner	1				
Maro	2			1	
Main Hawaiian Islands	1				
Midway	2				
Necker	3	1			
Nihoa	4				
Pearl and Hermes	3				

[1]Two monk seals reported sighted at Raita Bank bore NMFS tag numbers 35 and 743.

Table 10.--Permit and vessel activity in lobster fishery.

Year	Permits issued	Active vessels	Trap carrying capacity of active vessels	Average trap carrying capacity of active vessels
1983	14	4	1,200	300
1984	19	11	5,240	476
1985	45	16	12,250	703
1986	54	16	13,580	849

Table 11.--Violations of spiny lobster regulations 1986.
EAR = enforcement action report.

	Violation	Action
1.	Failure to report 24 h in advance	Verbal warning
2.	Failure to keep accurate logs	Verbal warning
3.	Retention of three (3) short lobsters	Verbal warning
4.	Failure to submit sales log	EAR issued
5.	Retention of two (2) short lobsters	Verbal warning
6.	Failure to submit sales log	EAR issued
7.	Failure to submit sales log	EAR issued
8.	Fishing for lobsters in a closed area	Pending
9.	Retention of two (2) short lobsters	Verbal warning
10.	Failure to report 24 h in advance	Verbal warning

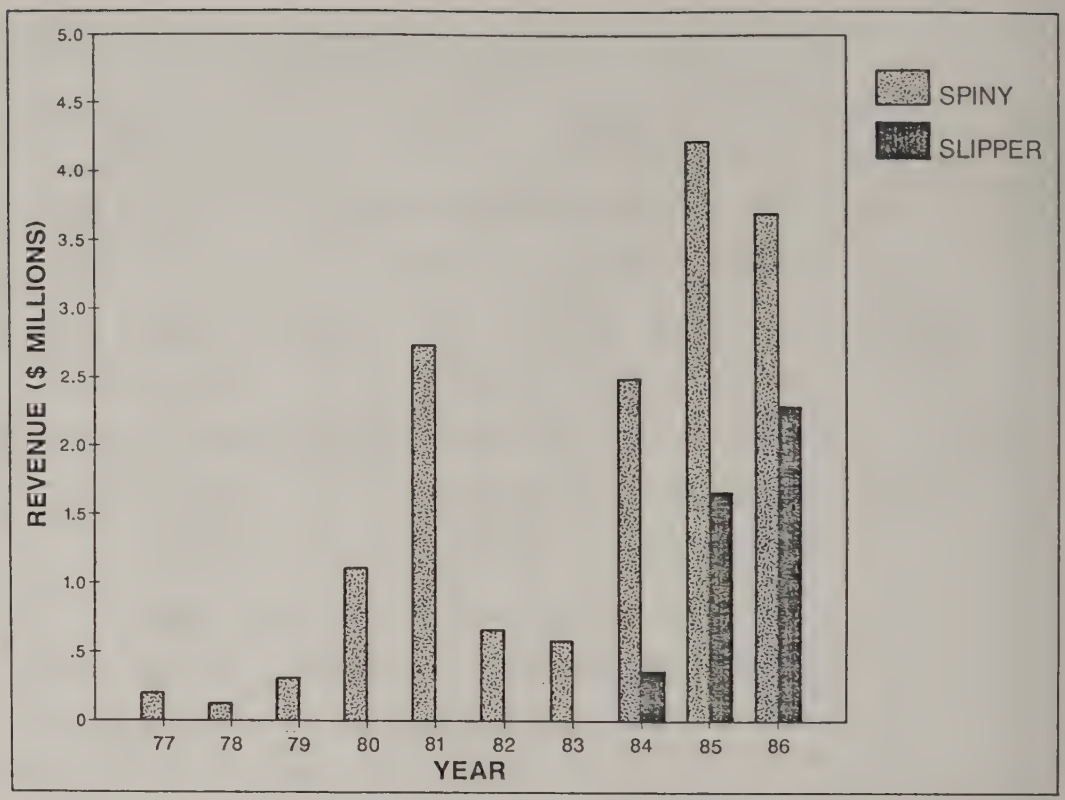

Figure 1.--Revenue for spiny and slipper lobsters in the Northwestern Hawaiian Islands fishery for 1977-86.

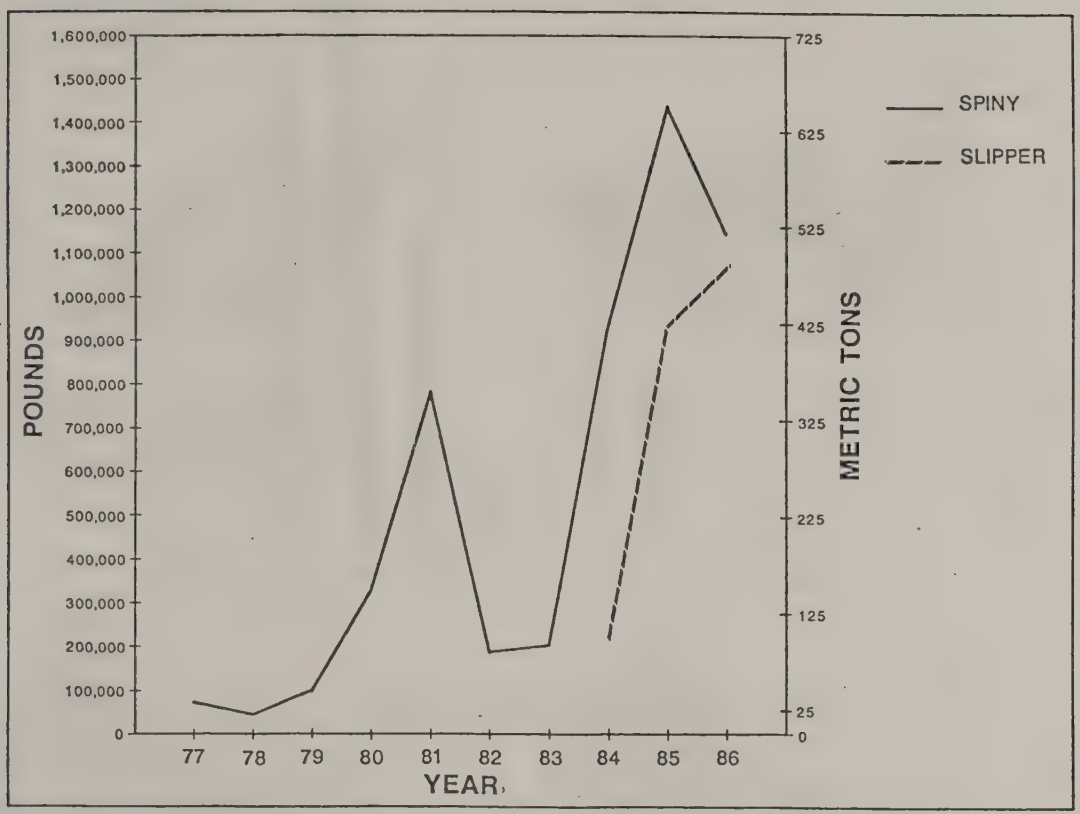

Figure 2.--Estimated annual landings of spiny and slipper lobsters in the Northwestern Hawaiian Islands lobster fishery for 1977-86 (wet weight).

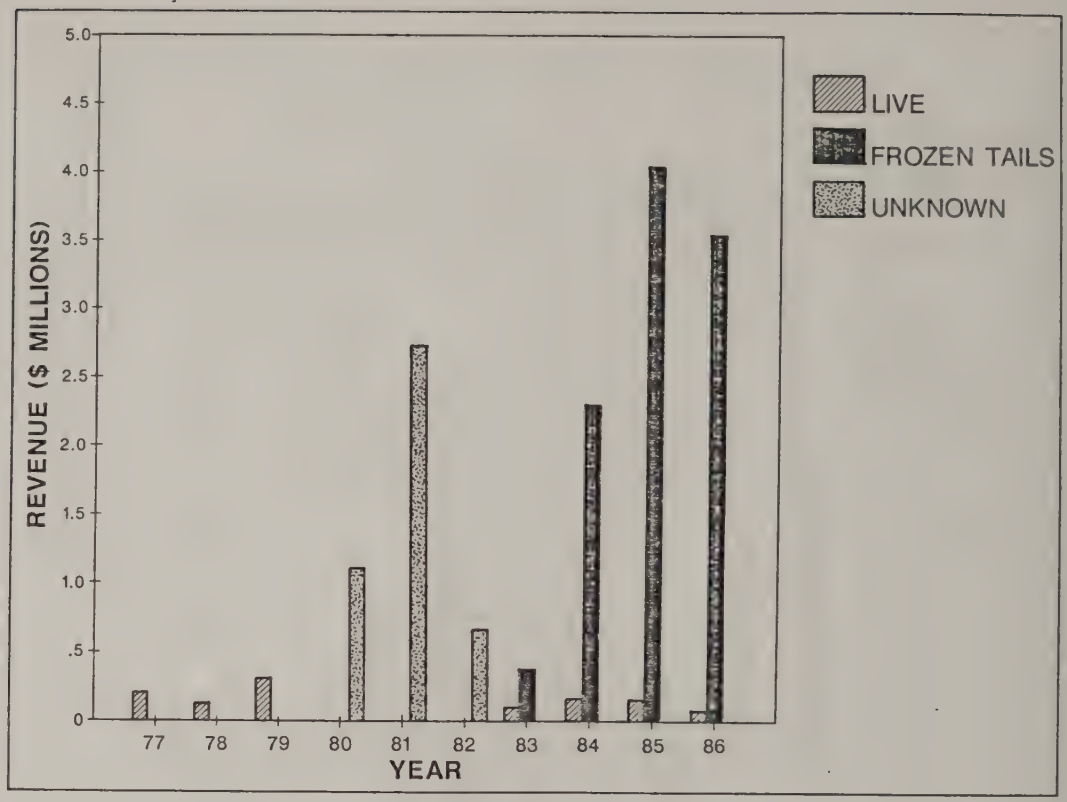

Figure 3.--Revenue of spiny lobster by produce type in the Northwestern Hawaiian Islands for 1977-86. (Frozen whole not shown.)

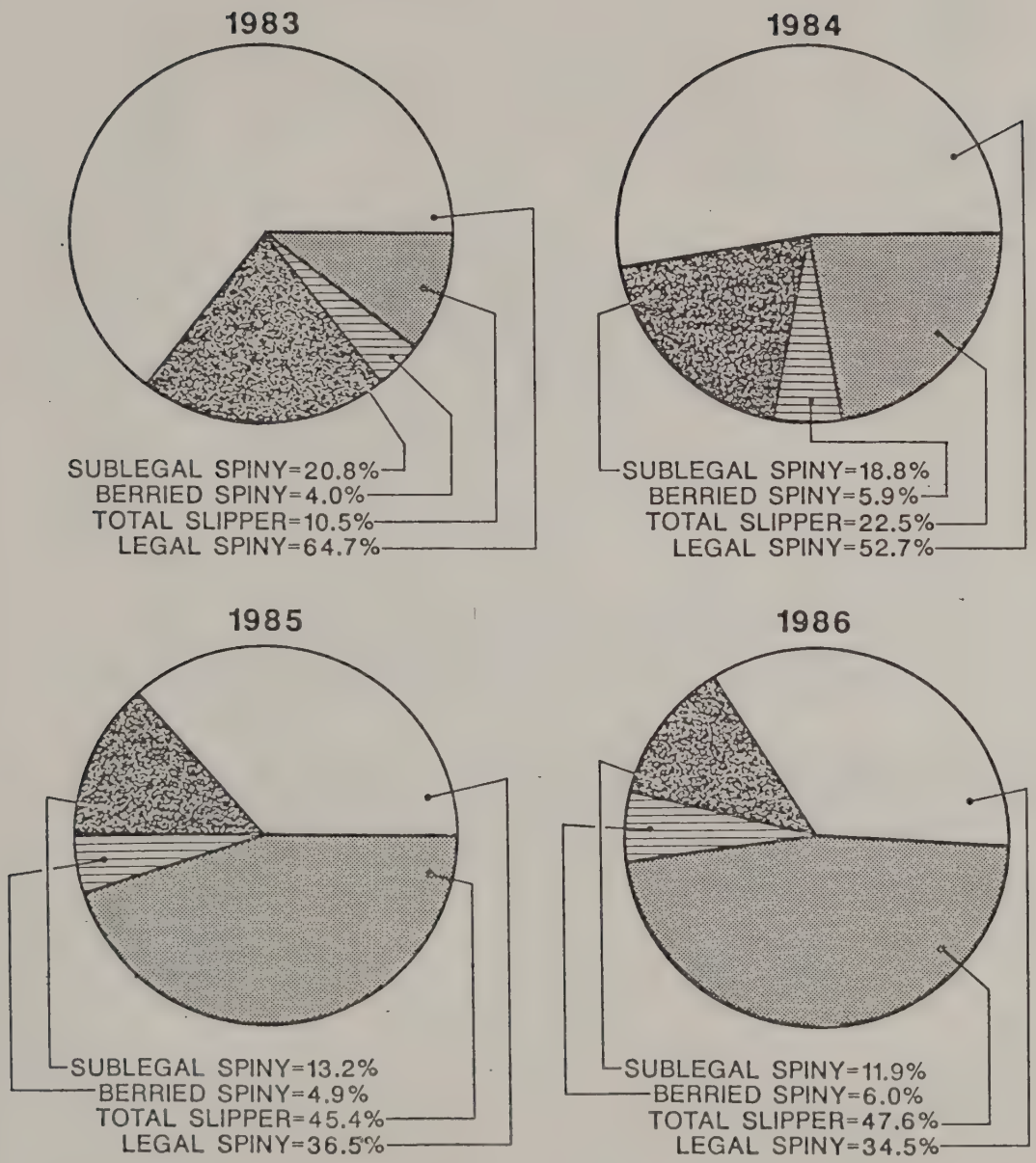

Figure 4.--Percent of the Northwestern Hawaiian Islands catch by species category for 1983-86.

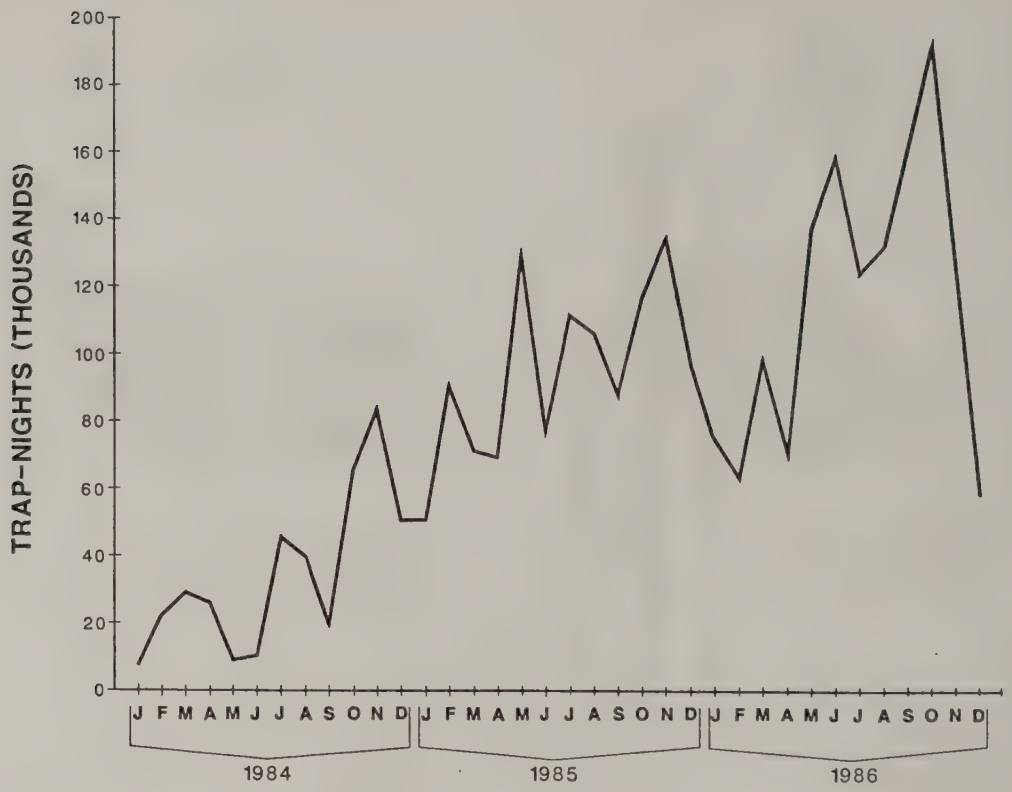

Figure 5A.--Seasonal trend of effort in trap-nights, calculated by date of haul in the Northwestern Hawaiian Islands lobster fishery for 1984-86.

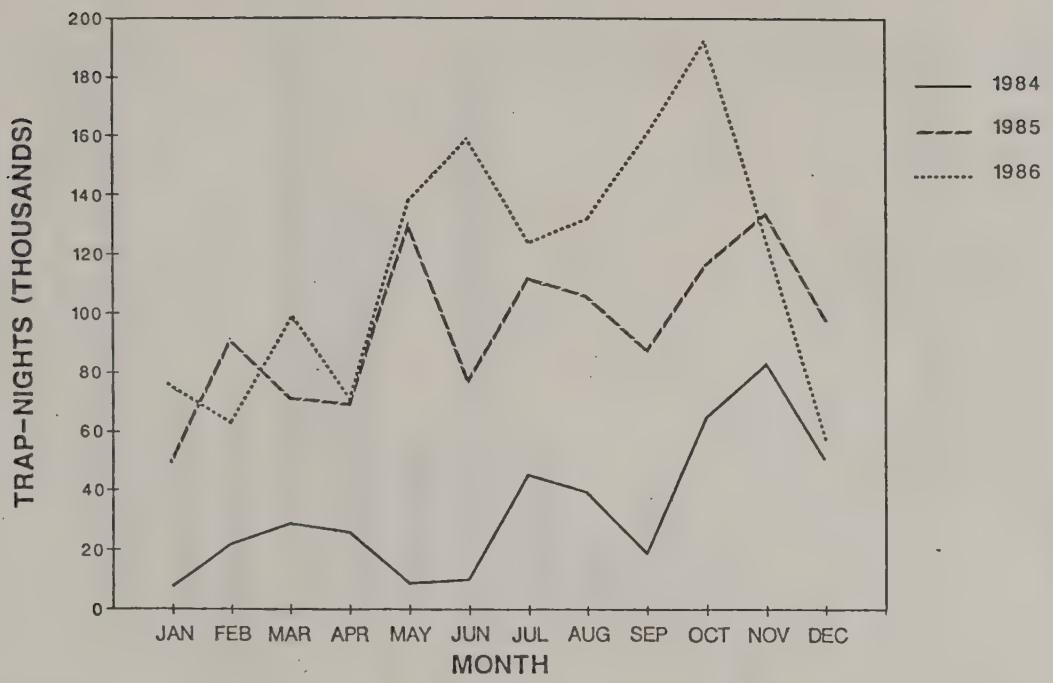

Figure 5B.--Yearly trend of effort in trap-nights, calculated by date of haul in the Northwestern Hawaiian Islands lobster fishery for 1984-86.

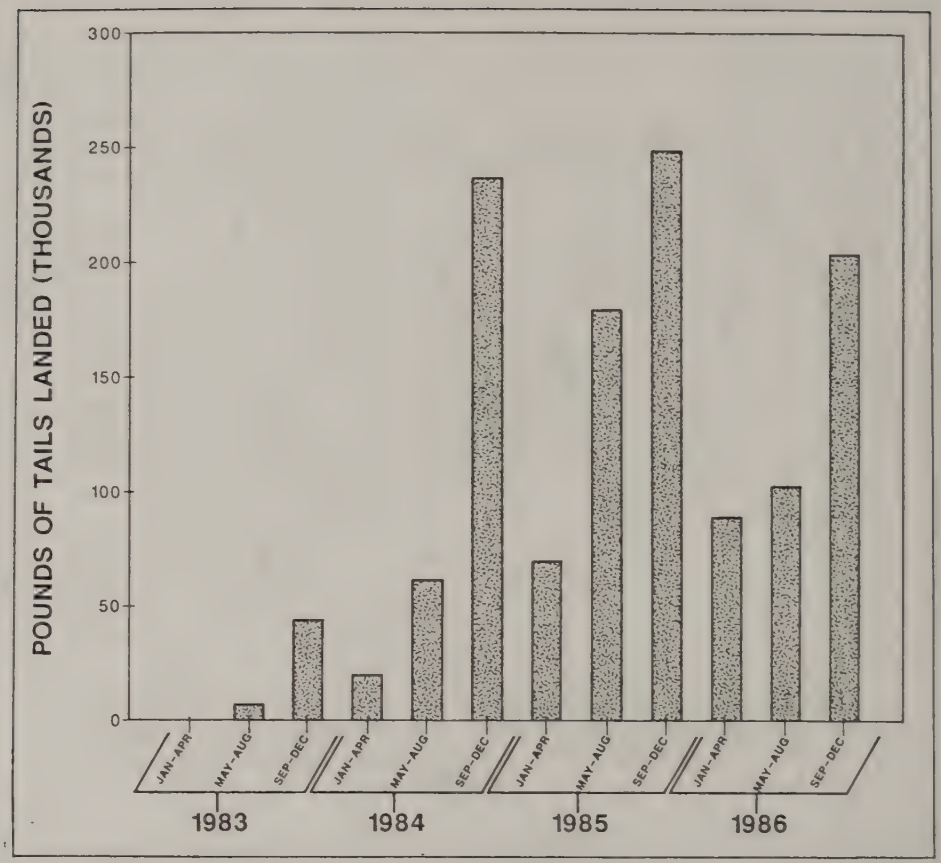

Figure 6.--Yearly trend of spiny lobster tail landings in the Northwestern Hawaiian Islands lobster fishery for 1983-86.

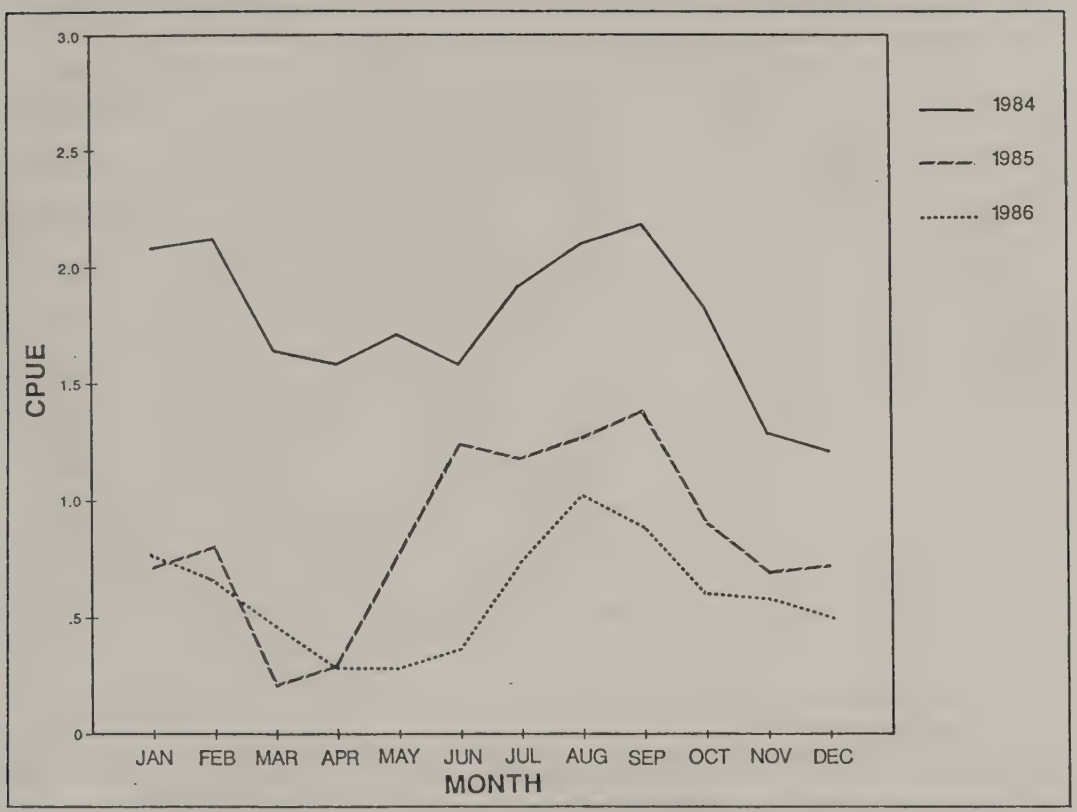

Figure 7.--Catch per trap-night of legal spiny lobster, calculated by using date of haul for the Northwestern Hawaiian Islands lobster fishery for 1984-86.

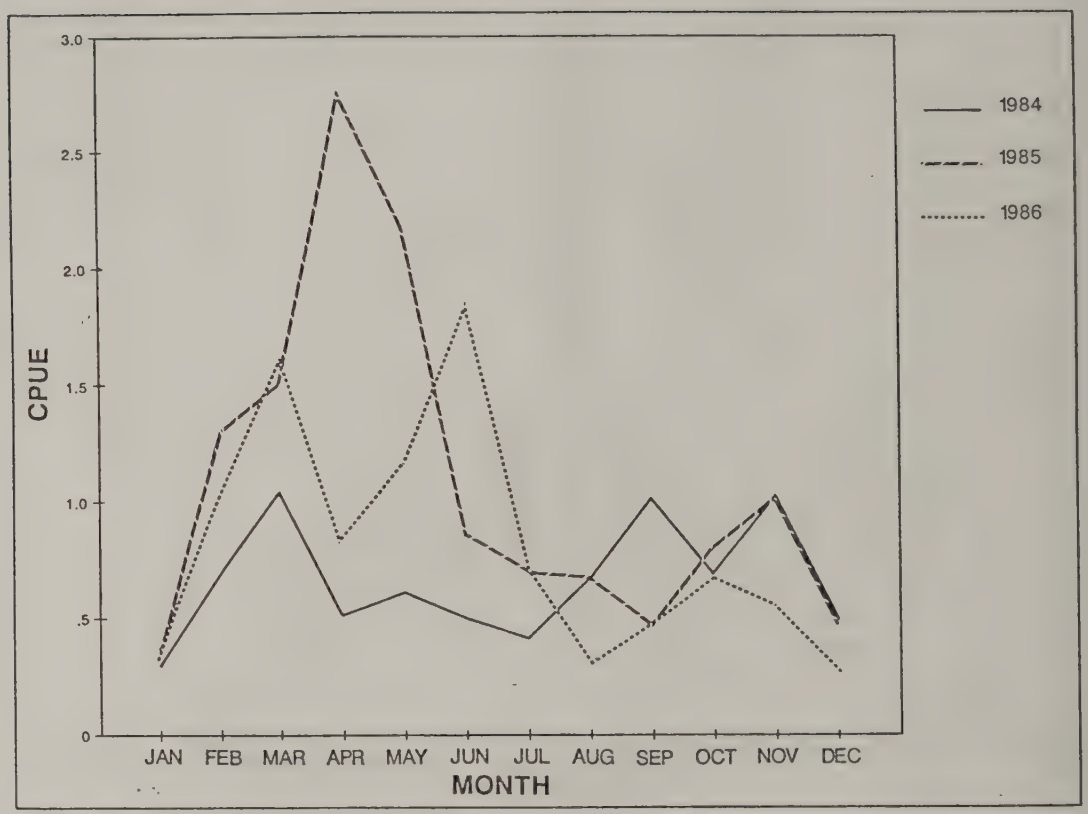

Figure 8.--Catch per trap-night of total slipper lobster, calculated by using date of haul for the Northwestern Hawaiian Islands lobster fishery for 1984-86.

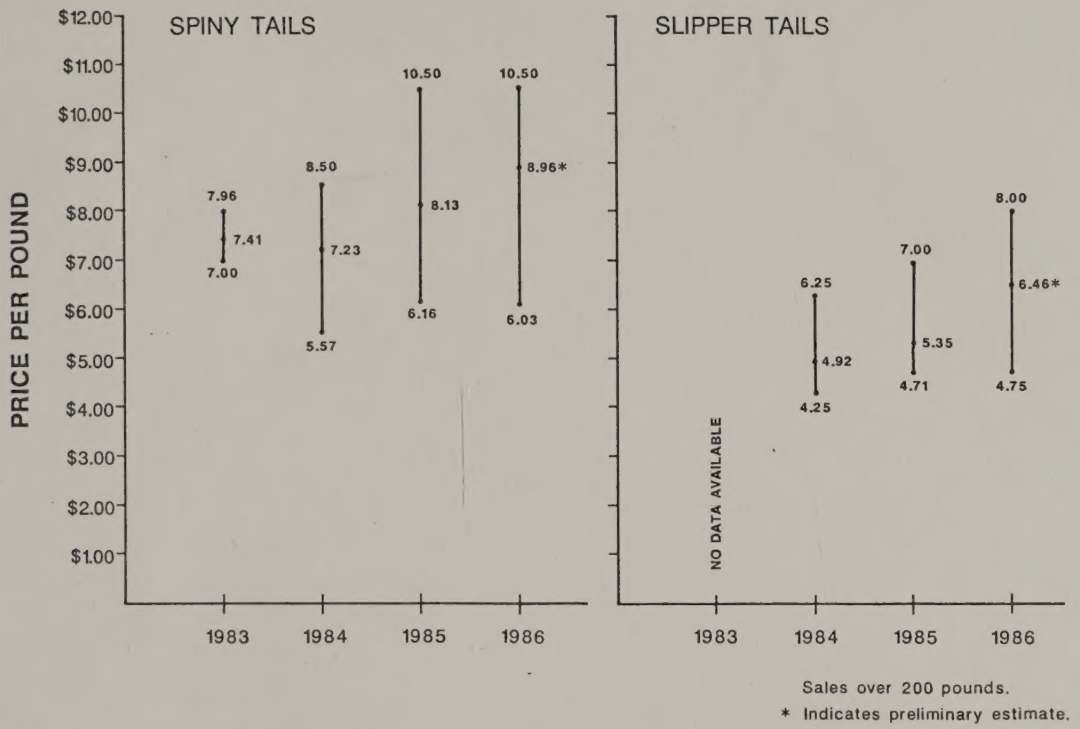

Figure 9.--Average ex-vessel price of spiny and slipper lobster frozen tails with high and low values paid in that year for 1983-86.